PYROLYSIS OF HAZELNUT SHELLS – TEAM 1.3

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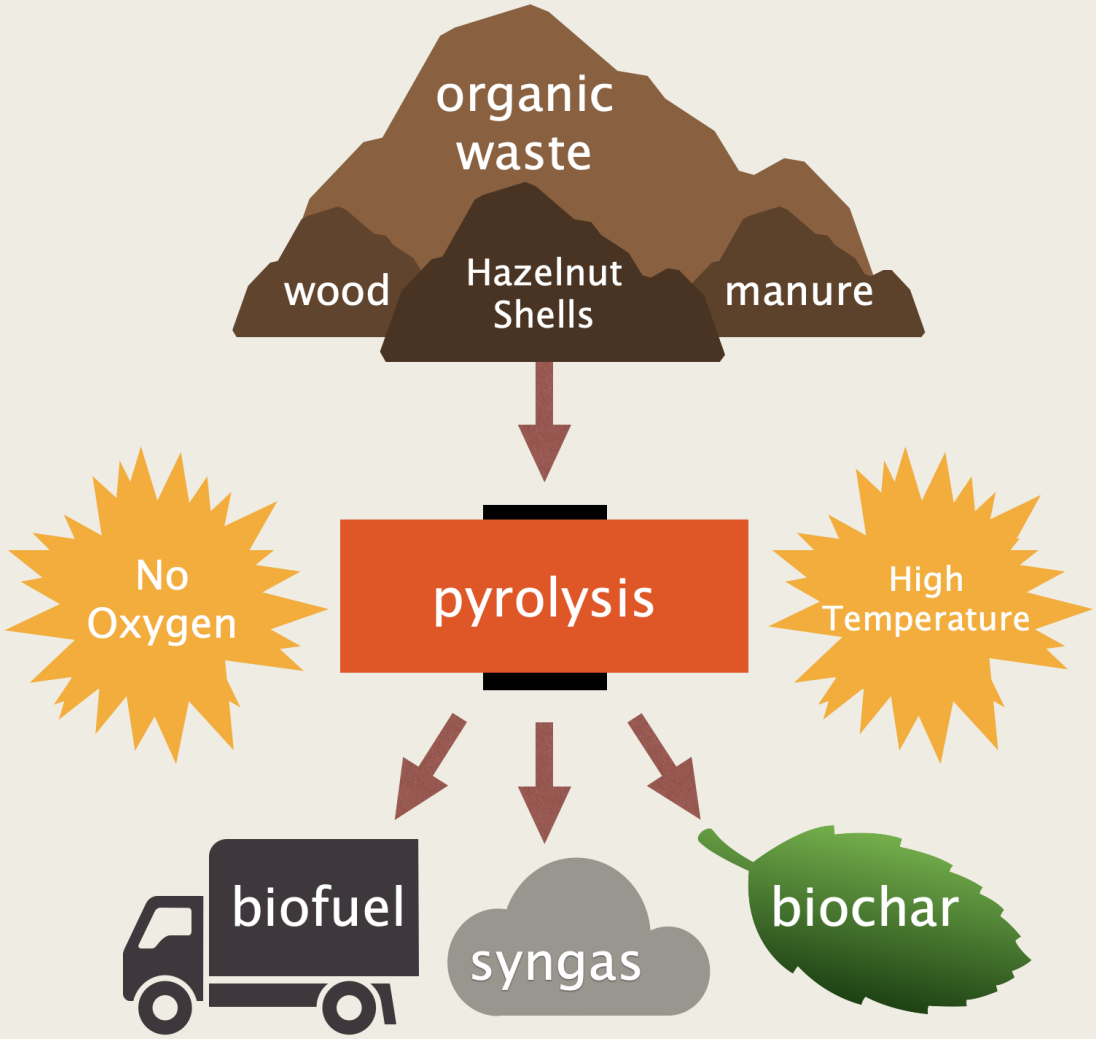
Background

- Clark Farm and Nursery, Cascade Foods handles 10,000 tons of hazelnuts each year
- Hazelnut shells currently sold to be blended into livestock pellets
  - *Sold at $7.50/ton*
  - *Kept in dedicated trailer onsite*
- Goal: create biochar from hazelnut shells
  - *Design pyrolysis unit*
    - Safe
    - Inexpensive
  - *Increase value of hazelnut shells*

CASCADE FOODS LLC

Introduction

- Pyrolysis: Bring biomass to a high temperature with no oxygen[1]
  - *Produce syngas, bio-oil, and biochar*
  - *Change temperature and particle size to change output*[2]
- Biochar: charcoal output from pyrolysis
  - *Typically used as a soil amendment*
    - Increases water and nutrient retention capacity of soil
    - Can sequester carbon for over 1000 years[3]

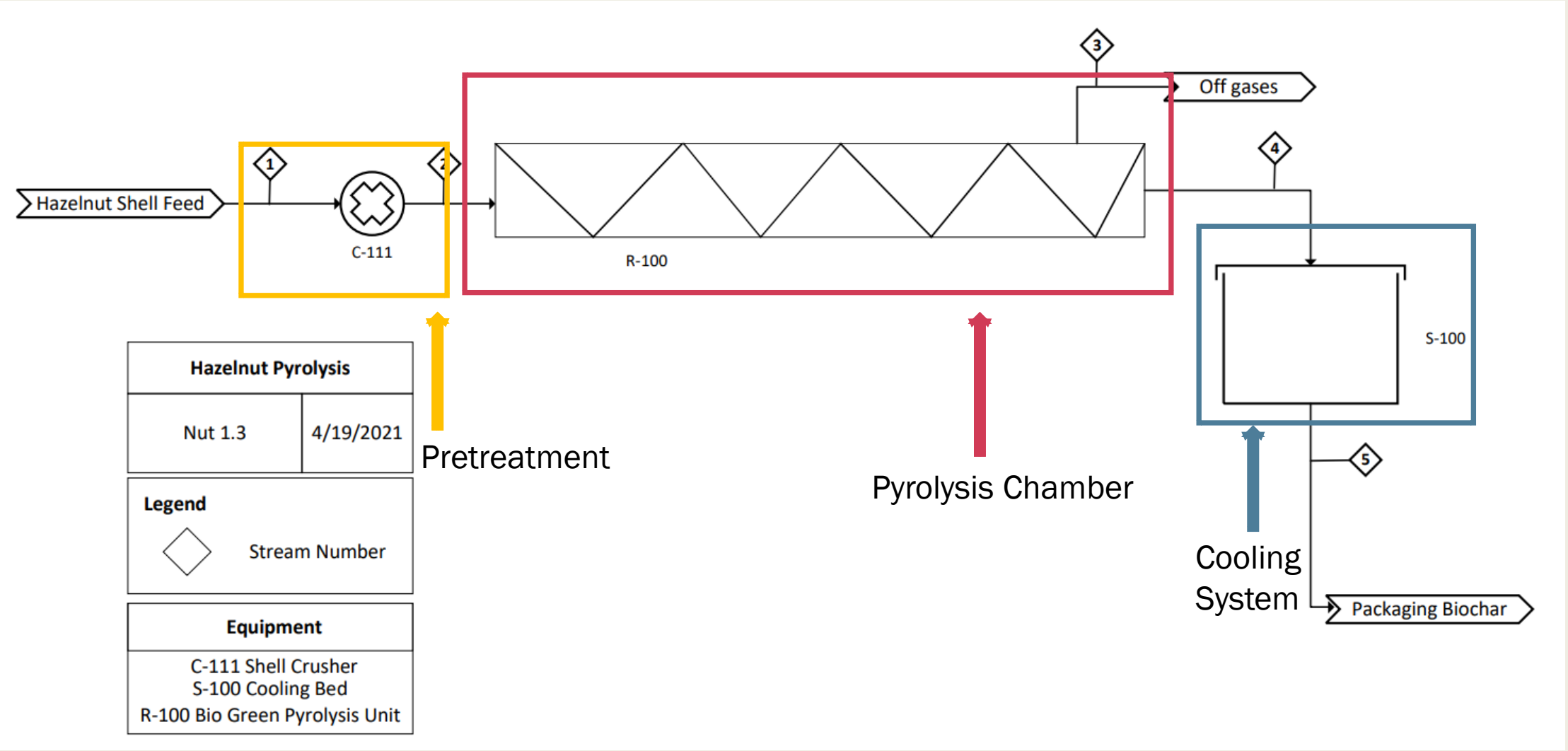


1. Zaman, C. Z., et al (2017). Pyrolysis: A Sustainable Way to Generate Energy from Waste. *Pyrolysis*.

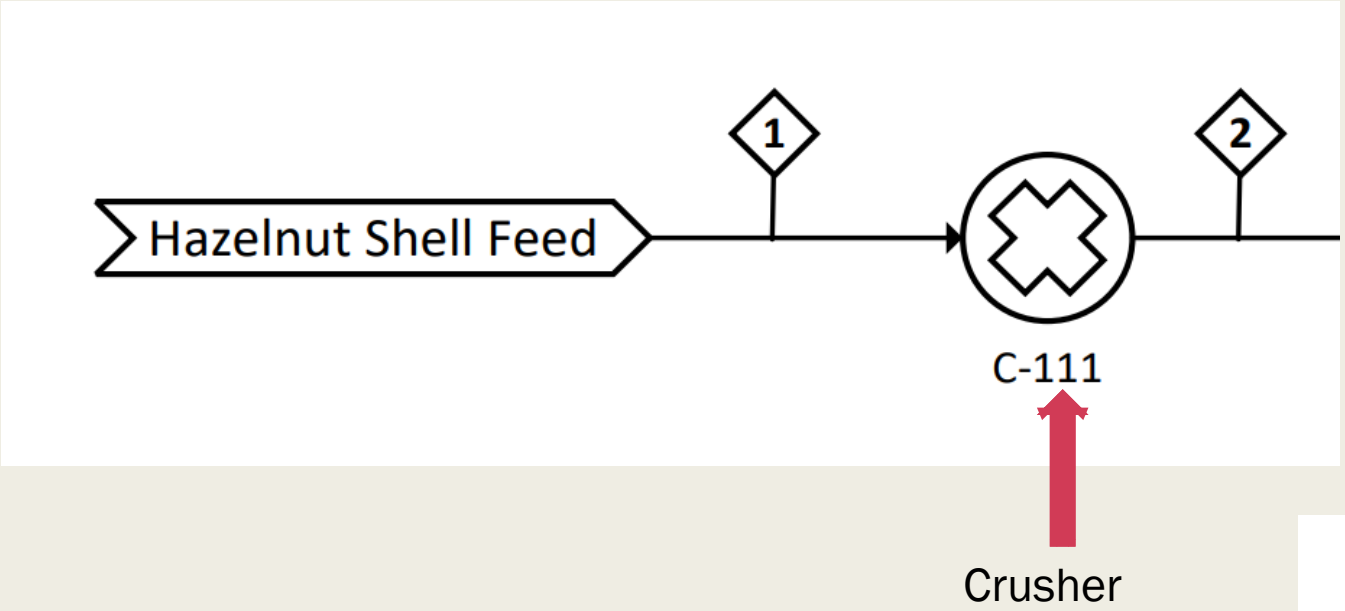
2. Di Blasi, et al. (2015). Role of Pretreatments in the Thermal Runaway of Hazelnut Shell Pyrolysis. *Energy & Fuels.*

3. Brassard, P., et al. (2019). Biochar for Soil Amendment. In M. Jeguirim & L. Limousy (Eds.), Char and Carbon Materials Derived from Biomass

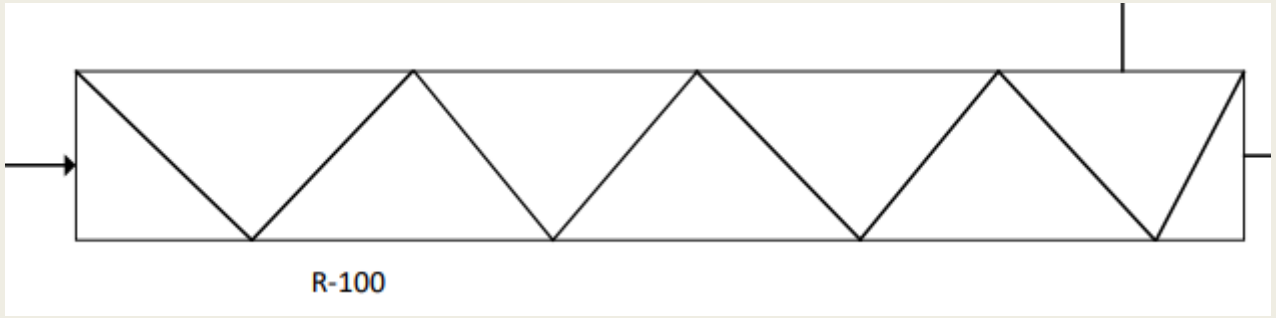
Pyrolysis Design



Pretreatment



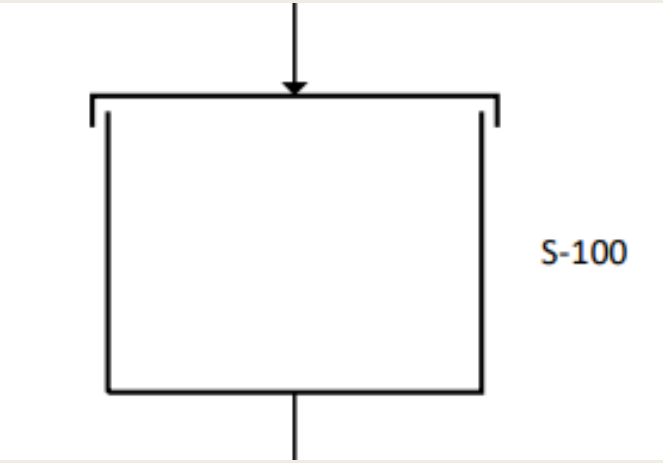
Pyrolysis Chamber



Pyrolysis Chamber

Biogreen chamber

Cooling System



Trailer Bed

Safety Provisions

Job Hazard Analysis

Reviews hazards for each piece of equipment

Propose controls to prevent hazards

Regular Maintenance

Strict maintenance schedule

Ensures equipment is working properly

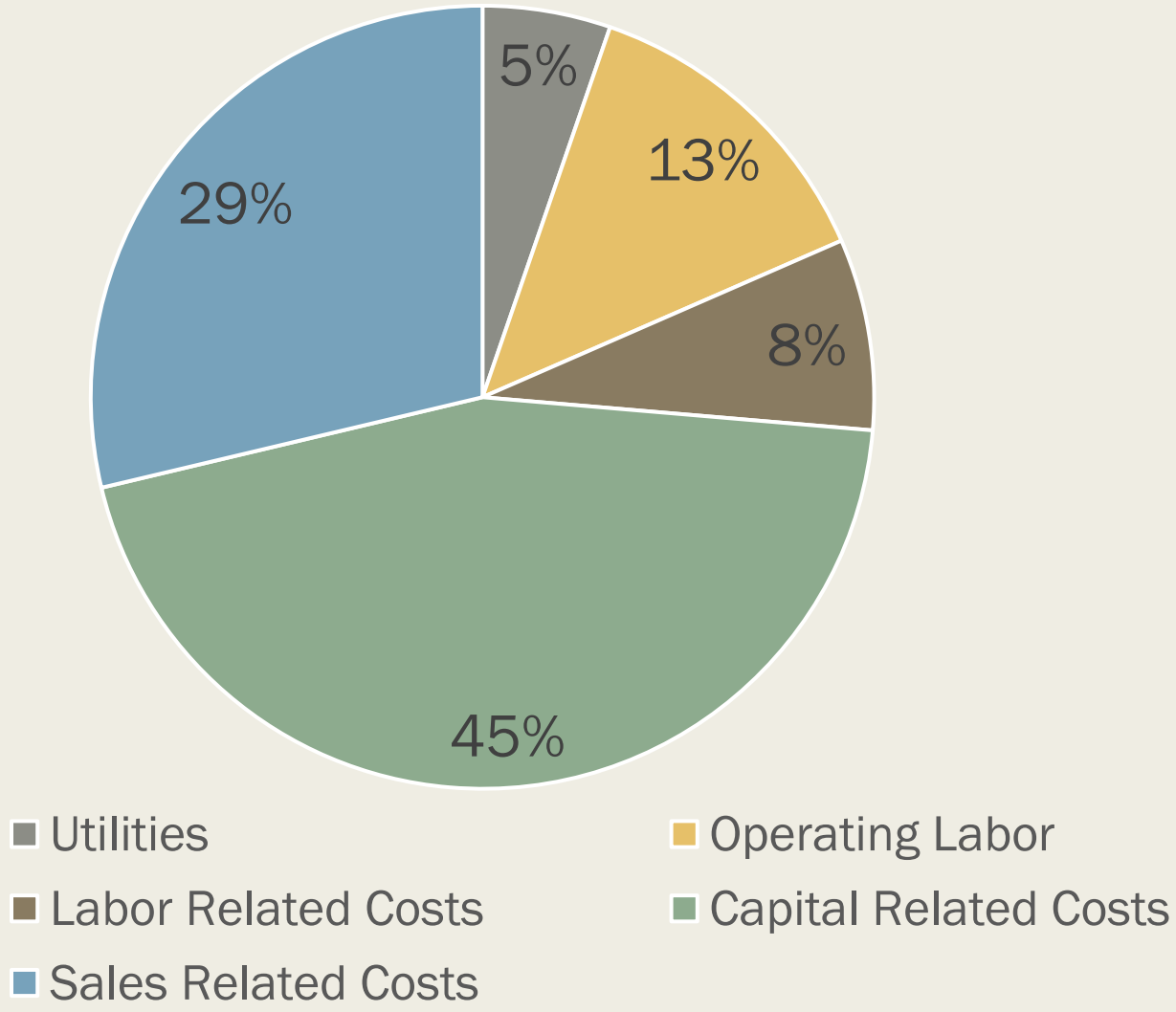
Major Safety Features

Nitrogen purge for O_2 levels greater than 5 vol%

Pyrolyzer operates below ambient pressure

Automatic and manual emergency stops

Costing and Profitability



- Payback Period: 5 years
- Price per ton: $1870
- Net Present Value: $2.7 million

Final Recommendations

- Pre-treatment
  - *Crushing to 8 mm*
- Biogreen Pyrolysis Chamber
  - *Operate at 450° C*
- Cooling Method
  - *System of 2 trailers*
  - *Emptied every 2 weeks*
- Profitability
  - *5 year payback period*
  - *NPV of $2.7 million*